Decision Making and Investment Planning

Managing Infrastructure Assets

This document is the seventh in a series of best practices that transform complex and technical material into non-technical principles and guidelines for decision making. For titles of other best practices in this and other series, please refer to ***<www.infraguide.ca>.***

National Guide to Sustainable Municipal Infrastructure

NRC·CNRC Federation of Canadian Municipalities Canada

Managing Infrastructure Assets

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InfraGuide®—Innovations and Best Practices

Why Canada Needs InfraGuide

Canadian municipalities spend $12 to $15 billion annually on infrastructure but it never seems to be enough. Existing infrastructure is ageing while demand grows for more and better roads, and improved water and sewer systems responding both to higher standards of safety, health and environmental protection as well as population growth. The solution is to change the way we plan, design and manage infrastructure. Only by doing so can municipalities meet new demands within a fiscally responsible and environmentally sustainable framework, while preserving our quality of life.

This is what the National Guide to Sustainable Municipal Infrastructure (InfraGuide) seeks to accomplish.

In 2001, the federal government, through its Infrastructure Canada Program (IC) and the National Research Council (NRC), joined forces with the Federation of Canadian Municipalities (FCM) to create the National Guide to Sustainable Municipal Infrastructure (InfraGuide). InfraGuide is both a new, national network of people and a growing collection of published best practice documents for use by decision makers and technical personnel in the public and private sectors. Based on Canadian experience and research, the reports set out the best practices to support sustainable municipal infrastructure decisions and actions in six key areas: municipal roads and sidewalks, potable water, storm and wastewater, decision making and investment planning, environmental protocols, and transit. The best practices are available on-line and in hard copy.

A Knowledge Network of Excellence

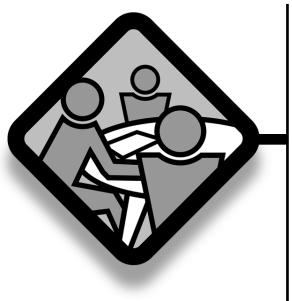
InfraGuide's creation is made possible through $12.5 million from Infrastructure Canada, in-kind contributions from various facets of the industry, technical resources, the collaborative effort of municipal practitioners, researchers and other experts, and a host of volunteers throughout the country. By gathering and synthesizing the best Canadian experience and knowledge, InfraGuide helps municipalities get the maximum return on every dollar they spend on infrastructure—while being mindful of the social and environmental implications of their decisions.

Volunteer technical committees and working groups—with the assistance of consultants and other stakeholders—are responsible for the research and publication of the best practices. This is a system of shared knowledge, shared responsibility and shared benefits. We urge you to become a part of the InfraGuide Network of Excellence. Whether you are a municipal plant operator, a planner or a municipal councillor, your input is critical to the quality of our work.

Please join us.

Contact InfraGuide toll-free at **1-866-330-3350** or visit our Web site at ***www.infraguide.ca*** for more information. We look forward to working with you.

The InfraGuide Best Practices Focus



Decision Making and Investment Planning

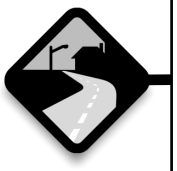
Elected officials and senior municipal administrators need a framework for articulating the value of infrastructure planning and maintenance, while balancing social, environmental and economic factors. Decision-making and investment planning best practices transform complex and technical material into non-technical principles and guidelines for decision making, and facilitate the realization of adequate funding over the life cycle of the infrastructure. Examples include protocols for determining costs and benefits associated with desired levels of service; and strategic benchmarks, indicators or reference points for investment policy and planning decisions.

Potable Water

In keeping with the adage "out of sight, out of mind", the water distribution system has been neglected in many municipalities. Potable water best practices address various approaches to enhance a municipality's or water utility's ability to manage drinking water delivery in a way that ensures public health and safety at best value and on a sustainable basis. The up-to-date technical approaches and practices set out on key priority issues will assist municipalities and utilities in both decision making and best-in-class engineering and operational techniques. Issues such as water accountability, water use and loss, deterioration and inspection of distribution systems, renewal planning and technologies for rehabilitation of potable water systems and water quality in the distribution systems are examined.

Storm and Wastewater

Ageing buried infrastructure, diminishing financial resources, stricter legislation for effluents, increasing public awareness of environmental impacts due to wastewater and contaminated stormwater are challenges that municipalities have to deal with. Storm and wastewater best practices deal with buried linear infrastructure as well as end of pipe treatment and management issues. Examples include ways to control and reduce inflow and infiltration; how to secure relevant and consistent data sets; how to inspect and assess condition and performance of collections systems; treatment plant optimization; and management of biosolids.

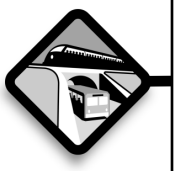


Municipal Roads and Sidewalks

Sound decision making and preventive maintenance are essential to managing municipal pavement infrastructure cost effectively. Municipal roads and sidewalks best practices address two priorities: front-end planning and decision making to identify and manage pavement infrastructures as a component of the infrastructure system; and a preventive approach to slow the deterioration of existing roadways. Example topics include timely preventative maintenance of municipal roads; construction and rehabilitation of utility boxes; and progressive improvement of asphalt and concrete pavement repair practices.

Environmental Protocols

Environmental protocols focus on the interaction of natural systems and their effects on human quality of life in relation to municipal infrastructure delivery. Environmental elements and systems include land (including flora), water, air (including noise and light) and soil. Example practices include how to factor in environmental considerations in establishing the desired level of municipal infrastructure service; and definition of local environmental conditions, challenges and opportunities with respect to municipal infrastructure.



Transit

Urbanization places pressure on an eroding, ageing infrastructure, and raises concerns about declining air and water quality. Transit systems contribute to reducing traffic gridlock and improving road safety. Transit best practices address the need to improve supply, influence demand and make operational improvements with the least environmental impact, while meeting social and business needs.

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ACKNOWLEDGEMENTS

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Umendra Mital, Chair
City of Surrey, British Columbia

Clarke Bellinger
CH2MHILL, Ottawa, Ontario

Ed Kovacs
City of Cambridge, Ontario

Luc Lahaie
City of Laval, Quebec

Betty Matthews-Malone
County of Haldimand, Ontario

Osama Moselhi
Concordia University, Montréal, Quebec

Jean-Pierre Pierre
City of Clarence-Rockland, Ontario

Konrad Siu
City of Edmonton, Alberta

Peter Steblin
City of London, Ontario

George Trainor
City Councillor, Charlottetown
Prince Edward Island

Jeff Potkins
Technical Advisor
National Research Council Canada
Ottawa, Ontario

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Guy Courtnay
Dillon Consulting Ltd., Toronto, Ontario

Gerry Davis
City of Hamilton, Ontario

Doug Floyd
Delcan Corporation, Vancouver, British Columbia

Denis Gagnon
City of Québec, Quebec

Robert Shamess
City of Kitchener, Ontario

Dana Vanier
National Research Council Canada
Ottawa, Ontario

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Governing Council:

Joe Augé
Government of the Northwest Territories
Yellowknife, Northwest Territories

Mike Badham
City of Regina, Saskatchewan

Sherif Barakat
National Research Council Canada
Ottawa, Ontario

Brock Carlton
Federation of Canadian Municipalities
Ottawa, Ontario

Jim D'Orazio
Greater Toronto Sewer and Watermain Contractors Association, Toronto, Ontario

Douglas P. Floyd
Delcan Corporation, Toronto, Ontario

Derm Flynn
Town of Appleton, Newfoundland and Labrador

John Hodgson
City of Edmonton, Alberta

Joan Lougheed, Councillor
City of Burlington, Ontario

Saeed Mirza
McGill University, Montréal, Quebec

Umendra Mital
City of Surrey, British Columbia

René Morency
Régie des installations olympiques

Vaughn Paul
First Nations (Alberta) Technical Services Advisory Group, Edmonton, Alberta

Ric Robertshaw
Public Works, Region of Peel, Brampton, Ontario

Dave Rudberg
City of Vancouver, British Columbia

Van Simonson
City of Saskatoon, Saskatchewan

Basil Stewart, Mayor
City of Summerside, Prince Edward Island

Serge Thériault
Government of New Brunswick
Fredericton, New Brunswick

Tony Varriano
Infrastructure Canada, Ottawa, Ontario

Alec Waters
Alberta Infrastructure Department
Edmonton, Alberta

Wally Wells
The Wells Infrastructure Group Inc.
Toronto, Ontario

Municipal Infrastructure Committee:

Al Cepas,
City of Edmonton, Alberta

Wayne Green
Green Management Inc.
Mississauga, Ontario

Haseen Khan
Government of Newfoundland and Labrador
St. John's, Newfoundland and Labrador

Ed S. Kovacs
City of Cambridge, Ontario

Saeed Mirza
McGill University, Montréal, Quebec

Umendra Mital
City of Surrey, British Columbia

Carl Yates
Halifax Regional Water Commission, Nova Scotia

Relationship Infrastructure Committee:

Geoff Greenough
City of Moncton, New Brunswick

Joan Lougheed, Councillor
City of Burlington, Ontario

Osama Moselhi
Concordia University, Montréal, Quebec

Anne-Marie Parent
Parent Latreille and Associates
Montréal, Quebec

Konrad Siu
City of Edmonton, Alberta

Wally Wells
The Wells Infrastructure Group Inc.
Toronto, Ontario

Founding Member:

Canadian Public Works Association (CPWA)

EXECUTIVE SUMMARY

This document describes the fundamental concepts, components, and considerations inherent in an asset management plan as a municipal best practice. Asset management has been described as "a systematic process of maintaining, upgrading, and operating physical assets cost-effectively. It combines engineering principles with sound business practices and economic theory, and it provides tools to facilitate a more organized, logical approach to decision-making. Thus asset management provides a framework for handling both short- and long-range planning" (US, Department of Transport (DOT), 1999).

Canadian municipalities are realizing that an asset management plan will be required to address the rising costs for, and competing priorities associated with, infrastructure renewal programs. An asset management plan is also needed to address public demands for a higher level of service, more stringent regulations, population changes, limited financial resources, competition, and technology.

Benefits And Challenges

Asset management provides transparent, rational, and accountable cost-effective management of municipal infrastructure systems with best value for money, saving unnecessary cost. In this capacity, asset management could be viewed as a value management program at strategic and tactical levels. Specific benefits include:

- facilitates the establishment and subsequent implementation of policy objectives and the related measurement of performance;
- helps in avoiding problems and potential crises;
- provides better and consistent levels of service to the public, at less cost;
- leads to improved and more effective communication with the public;
- improves evaluation of return on investment;
- reduces life cycle costs;
- improves service and performance;
- allows for better decisions regarding resource allocation;
- reduces risk to the municipality;
- leads to more effective communication with ratepayers, elected officials, financial rating organizations, and regulatory agencies;
- allows for more accurate financial planning;
- leads to more efficient data management; and
- results in positive institutional change.

There are several potential challenges in asset management planning.

- Realizing the promise engendered in an asset management plan, will be much easier if it is situated securely within the municipality's strategic and corporate business plan and has the approval of senior levels of the municipality. The lack of a corporate sponsor could result in a less than optimum overall corporate strategy with which to support the implementation of an asset management plan.
- The asset management plan must consider the overall life cycle costs of providing the service and be prepared to make investment decisions accordingly. Alternative investment decisions may result in increased funding requirements.
- There are significant challenges associated with developing a relevant and up-to-date database of infrastructure inventory, and condition and capacity information and analysis.

Key Principles

Asset management is characterized by several key principles, including asset value, life cycle management, long-term affordability, risk management and assessment, performance measurement, operational plans, and integration of technical and financial plans.

Asset management has been described as "a systematic process of maintaining, upgrading, and operating physical assets cost-effectively."

Two complementary approaches are used to develop an asset management plan, namely, a senior-directed approach and an operational approach. The senior-directed approach is used for strategic long-term planning of policies and programs. The operational approach is used for short-term capital and operational planning of projects. The operational approach requires a more detailed inventory and condition data than the senior-directed approach.

Essential Elements

The framework for an asset management plan can be described in terms of seven questions.

1. What do you have and where is it? (Inventory)
2. What is it worth? (Costs/replacement rates)
3. What is its condition and expected remaining service life? (Condition and capability analysis)
4. What is the level of service expectation, and what needs to be done? (Capital and operating plans)
5. When do you need to do it? (Capital and operating plans)
6. How much will it cost and what is the acceptable level of risk(s)? (Short- and long-term financial plan)
7. How do you ensure long-term affordability? (Short- and long-term financial plan)

This framework is applicable to both the senior-directed and operational approaches.

Implementation Needs

Implementation of an asset management plan requires people, information, and technology. A business plan should be prepared to outline the expected costs directly related to preparing and implementing the plan, and the benefits of implementation.

An implementation plan should identify the short- and long-term objectives of asset management, a work plan, roles and responsibilities, schedule and budget for various milestones, and the deliverables. This best practice identifies several challenges in implementing an asset management plan successfully, including institutional, technical, and funding challenges. Several key initiatives and emerging trends in asset management are described: the Civil Infrastructure Systems Technology Road Map, the Municipal Infrastructure Investment Planning project, benchmarking, technology tools, regulations, public-private partnerships, and continuous improvement.

Successful Implementations

This report summarizes several successful implementations of asset management in Canadian municipalities. However, successful implementation requires that municipalities overcome institutional, technical, and funding challenges before they can successfully implement asset management. Measures to overcome these challenges include:

- improved communication;
- education;
- training;
- advance planning; and
- information technology.

Asset Management Evaluation

Finally, an asset management plan should be evaluated to assess its effectiveness. This can be done through several means.

- Monitor the condition of the infrastructure to ensure that an adequate level of service is maintained over the long term. For this, a replicable condition rating system should be used.
- Monitor the performance of the infrastructure to ensure that an adequate level of service is maintained over the long term and to assess the efficiency and effectiveness of the municipality.
- Track unplanned spending on an annual basis to confirm that the asset management plan is effective. Implementation of an asset management plan should reduce unplanned spending over a period of years.

1. General

1.1 Introduction

In the past, most Canadian municipalities focused on expansion of their infrastructure (e.g., roads, bridges, sewers, water mains, and buildings) to support population growth. Now, many municipalities are realizing that the cost of renewing ageing infrastructures is increasing, and these infrastructures have to be considered as "assets."

Asset management is not a new concept. It has been widely used for many years in real estate, property management, finance, manufacturing, information technology, and other areas of private industry. However, in these cases, the assets are usually more easily converted into money and have a shorter life expectancy than is the case with municipal infrastructure. At the same time, abandoning or eliminating the asset at the end of its life is not typically an option for municipal infrastructure. Furthermore, private companies are motivated by profit, whereas the provision and stewardship of basic civil infrastructure is a fundamental and key responsibility of municipalities. Nevertheless, fundamental asset management concepts are still applicable to municipal infrastructure.

Municipal infrastructure requires ongoing investment to sustain it. In other words, municipal infrastructure has monetary value, and its components will not last forever.

The Federal Highway Administration (US, DOT, 1999) described asset management as "a systematic process of maintaining, upgrading, and operating physical assets cost-effectively. It combines engineering principles with sound business practices and economic theory, and it provides tools to facilitate a more organized, logical approach to decision-making. Thus asset management provides a framework for handling both short- and long-range planning." In other words, asset management should help municipalities identify the right amount of money to be spent on the right things, at the right time. Asset management is a "way of doing business," not just another program requiring another new bureaucracy.

1.2 Purpose and Scope

This best practice is intended to provide municipal infrastructure managers, elected officials, and technical staff with sufficient information to recognize the need to develop an asset management plan. The rationale for asset management as an intrinsic aspect of the municipal strategic and business process will become apparent. A related objective is the development of an appreciation among elected officials of their role as stewards of infrastructure assets and the service these assets provide, now and in the future. It is not intended to be a guide for the development of an asset management plan or for the implementation of an asset management system.

The report provides an overview of the components of municipal infrastructure asset management planning and its benefits to help elected officials and senior appointed officials and administrators realize the importance of developing and implementing a plan customized for their own municipalities. A municipal infrastructure asset management plan includes:

- key principles;
- essential elements;
- data collection;
- implementation needs;
- operational considerations;
- successful implementations; and
- emerging trends.

Asset management is not a new concept. It has been widely used for many years in real estate, property management, finance, manufacturing, information technology, and other areas of private industry.

1.3 How To Use this Document

Section 2 gives some background on asset management plans as well as the potential benefits and risks associated with their implementation.

Section 3 outlines a framework for an asset management plan.

Section 4 presents some considerations for implementation of an asset management plan.

Section 5 describes several measures to evaluate the effectiveness of asset management.

InfraGuide has already published several other best practices relevant to municipal infrastructure asset management, including the following.

Developing a Water Distribution System Renewal Plan — This document outlines two complementary approaches for the development of a water distribution system renewal plan. The senior-directed approach is used for strategic planning of policies and programs, whereas the operational approach is used for short-term capital planning of projects. Both approaches use a common framework, although they differ in terms of the level of detail. Examples are provided to illustrate the application of both approaches. A renewal plan is a key component of an asset management plan.

Municipal Infrastructure Reinvestment Parameters and Their Applications — This document describes four practices that can be used to achieve adequate levels of investment in municipal infrastructure. These methods include an infrastructure asset report model, high-level parameters, detailed level parameters, and improved communication.

Planning and Defining Municipal Infrastructure Needs — This document presents five practices to assist with planning and defining municipal infrastructure needs, namely, strategic planning, information management, building public support and acceptance, exploring new and innovative methods for continuous improvement, and prioritization models.

An Integrated Approach to Assessment and Evaluation of Municipal Road, Sewer, and Water Networks — This document outlines the need for integrated renewal planning of municipal road, sewer, and water systems at a network level. It describes a five-step procedure for assessment and evaluation of municipal infrastructure, including inventory, investigation, condition assessment, performance evaluation, and renewal planning.

Additional best practice reports and other documents related to this subject are available from the InfraGuide Web site <www.infraguide.gc.ca>.

1.4 Glossary

Asset — A physical component of a facility, which has value, enables services to be provided and has an economic life of greater than 12 months. Dynamic assets have some moving parts, while passive assets have none.

Asset management — The combination of management, financial, economic, engineering, operational and other practices applied to physical assets with the objective of providing the required level of service in the most cost-effective manner.

Asset management plan — A plan developed for the management of one or more infrastructure assets that combines multidisciplinary management techniques (including technical and financial) over the life cycle of the asset in the most cost effective manner to provide a specified level of service. A significant component of the plan is a long-term cash flow projection for the activities.

Asset management strategy — A strategy for asset management covering the development and implementation of plans and programs for asset creation, operation, maintenance, rehabilitation/replacement, disposal, and performance monitoring to ensure that the desired levels of service and other operational objectives are achieved at optimum cost.

Infrastructure — The term as used in InfraGuide refers to roads and sidewalks, potable water, wastewater, storm water, and transit.

Level of service — The defined service quality for a particular activity or service area against which service performance may be measured. Service levels usually relate to quality, quantity, reliability, responsiveness, environmental acceptability, and cost.

Life cycle costing — A method of expressing cost, in which both capital costs and operations and maintenance costs are considered, to compare alternatives. "Present worth" is one way to express life cycle costs. The present worth represents the current investment that would have to be made at a specific discount (or interest) rate to pay for the initial and future cost of the works.

Rehabilitation — Works to rebuild or replace parts or components of an asset, to restore it to a required functional condition and extend its life, which may incorporate some modification. Generally involves repairing the asset to deliver its original level of service without resorting to significant upgrading or renewal, using available techniques and standards.

Replacement — The complete replacement of an asset that has reached the end of its service life, to provide an alternative that satisfies a targeted level of service.

Reinvestment — Funds allocated to capital projects that are rebuilding the existing municipal infrastructure asset base. New capacities and operations are excluded from infrastructure reinvestment decisions.

Service life — The period that an asset provides an acceptable level of service. The economic service life is defined as the period when the present worth of the future maintenance costs are equal to the present worth of its replacement.

2. Rationale

2.1 Background

Historically, many Canadian municipalities have used a reactive approach to managing municipal infrastructure. While many municipalities have implemented pavement management systems, most do not have asset management plans for their water and sewer systems. Typically, these systems have a longer service life than roads, but their condition is not as apparent—water and sewer systems are "out-of-sight and, therefore, out-of-mind." Furthermore, only a few municipalities have an integrated asset management plan for their road, sewer, and water systems.

The following paragraphs describe factors prompting municipalities to manage infrastructure proactively.

2.1.1 Ageing Infrastructure

In Canada, some municipal infrastructures are over 100 years old and have reached the end of their service life. In addition, most Canadian municipalities experienced significant population growth in the two decades following World War II (i.e., baby boomers) and the proportional increase in municipal infrastructure. As this infrastructure reaches the end of its service life, the reinvestment in infrastructure renewal will have to increase accordingly to address the echo from the investment in infrastructure in the two decades following World War II.

2.1.2 Public Demands For High Levels of Service

The Canadian public demands higher levels of service from their municipalities. The public is also becoming less tolerant of such things as water supply interruptions, potholes in roads, and sewer backups. Consequently, municipalities will need to quantify the costs of providing a high level of service.

2.1.3 Stringent Regulations

All levels of government are implementing more stringent regulations related to public health and safety, the environment, and financial issues. For example, new regulations to define more stringent water quality criteria for drinking water as well as wastewater and storm water discharges will require additional investments in municipal infrastructure.

2.1.4 Population Growth/Decline

Municipalities need to balance their investment in terms of population growth or decline. Many municipalities rely on the additional revenue generated from population growth to cover some of the costs for renewing older infrastructure. However, this approach is not sustainable. When a municipality experiences a declining population and revenue base, efforts must be made to maintain only those essential services and to decommission those no longer needed to provide a given level of service to the community.

2.1.5 Liability/Risk Management

Many municipalities are self-insured, and need to exercise and demonstrate an acceptable degree of due diligence in their infrastructure stewardship role. In some cases, "minimum" service standards are being set by provincial governments, which can be used as a test of due diligence in cases of litigation.

2.1.6 Limited Financial Resources

Demands for public money (i.e., taxes and utility fees) are increasing as the cost for social programs and hard services increases across Canada. In some cases, taxes and user rates have not increased sufficiently to compensate for inflation, increased maintenance responsibilities, or new facilities. Furthermore, some municipalities have borrowed money to cover the capital cost for municipal infrastructure, and the high cost of

While many municipalities have implemented pavement management systems, most do not have asset management plans for their water and sewer systems.

debt repayment has limited their ability to undertake other major renewal programs. Grants for infrastructure programs, from senior levels of government, have dwindled as the competition for funding has grown.

2.1.7 Increased Accountability

The Canadian public is becoming more demanding of governments in terms of accountability and transparent decision making. Governments should have a long-term plan for their infrastructure that quantifies the relationship between the level of service and the cost of the service. As well, benchmarking may help municipalities improve overall efficiency and effectiveness.

2.1.8 Competition

As the global economy evolves, an increasing number of private companies will be able to provide many services traditionally provided by municipalities.

2.1.9 Technology

Significant advances in technology improve the ability of municipalities to compile detailed inventories of their infrastructure, analyze the asset condition, evaluate renewal alternatives, and project the renewal needs.

2.1.10 Canadian Initiatives

To date, there have been few, if any, Canadian standards or guidelines for municipal infrastructure asset management. In 2002, the Canadian Institute of Chartered Accountants (CICA) explored the alternatives for accounting and financial reporting of infrastructure as assets, and other asset information that could be provided by governments (CICA, 2002). Further to this, the Public Sector Accounting Board of CICA recommended that senior levels of government adopt accrual-based private sector accounting practices for financial reporting purposes. This involves the capitalization and depreciation of tangible capital assts rather than the practice of expensing items.

In 2002, the Ontario government passed Bill 175 (Sustainable Water and Sewage Systems Act). This Act makes it mandatory for Ontario municipalities to assess and report on the full costs of providing water and sewage services, and then to prepare and implement plans for recovering these costs.

In 2002, the Ontario government passed Bill 175 (Sustainable Water and Sewage Systems Act). This Act makes it mandatory for Ontario municipalities to assess and report on the full costs of providing water and sewage services, and then to prepare and implement plans for recovering these costs. Similar legislation may be enacted in other parts of Canada over time. At the time of publishing this best practice, the Ontario government had not released the regulations defining the reporting requirements for the Sustainable Water and Sewage Systems Act.

2.1.11 International Initiatives

The Governmental Accounting Standards Board (US, GASB, 1999) in the United States introduced a requirement (known as GASB Statement 34) for state and local governments to account for their capital infrastructure assets and submit an annual report.

New Zealand and Australia have developed asset management guidelines in response to national legislation in both countries requiring government agencies to use asset management systems (Australian Accounting Standard 27 [AAS 27] Financial Reporting by Local Government).

Starting in the 1980s, Great Britain undertook a nationwide privatization of its water industry. To justify pricing, water utilities had to develop detailed asset management plans.

Several associations have published manuals and guides dealing with municipal infrastructure asset management. A listing of these references is provided at the end of this report.

2.2 Benefits

Asset management provides transparent, rational, and accountable cost-effective management of municipal infrastructure systems. It provides best value for money, saving unnecessary cost. In this capacity, asset management could be viewed as a value management program at strategic and tactical levels (Figure 2–1).

Figure 2–1: Corporate Strategic Framework for Asset Management

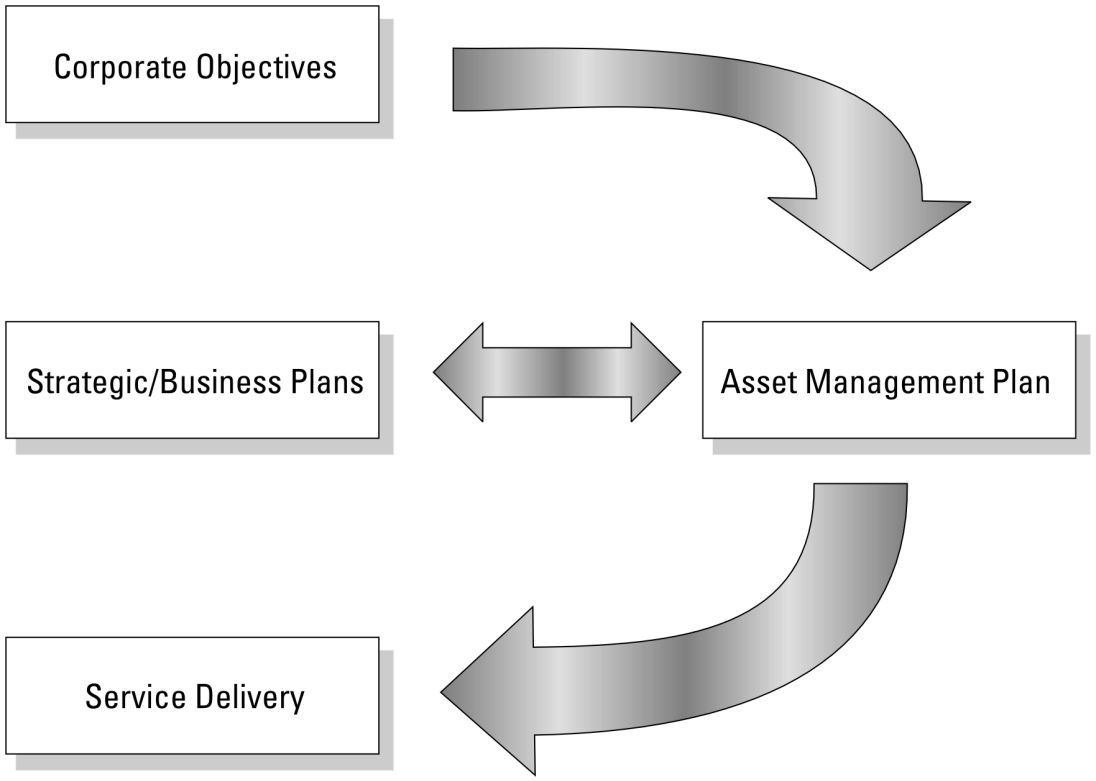


Figure 2–1:

Corporate Strategic Framework for Asset Management

Specific benefits include:

- facilitates the establishment and subsequent implementation of policy objectives and the related measurement of performance;
- helps avoid problems and potential crises;
- provides better and consistent levels of service to the public, at less cost;
- leads to improved and more effective communication with the public;
- improves evaluation of return on investment;
- reduces life cycle costs;
- improves service and performance;
- allows for better decisions regarding resource allocation;
- reduces risk to the municipality;
- leads to more effective communication with ratepayers, elected officials, financial rating organizations, and regulatory agencies;
- allows for more accurate financial planning;
- leads to more efficient data management; and
- results in positive institutional change.

2.3 Challenges

There are several potential challenges in asset management planning.

One of the greatest challenges lies in securing consistent and unmitigated advocacy from senior levels of the municipality. An approach, driven by senior management will be a big factor in securing the promise engendered in an asset management plan, on condition that it is situated securely within the municipality's strategic and corporate business plan.

Meaningful and comprehensive communication among relevant municipal staff, elected officials and, of course, the public is also a challenge. Asset management could be viewed as a program a municipality cannot afford that requires additional resources (i.e., staff and equipment) and is without significant short-term benefits. There could be a lack of support for an asset management plan from some stakeholders (e.g., operators, politicians, and the public) for those municipalities that have not yet experienced significant problems or if long-term benefits are not clearly identified.

Meaningful and comprehensive communication among relevant municipal staff, elected officials and, of course, the public is also a challenge.

Implementation of an asset management plan could be challenging if it is not well defined and endorsed by all stakeholders. Members of the asset management team must have a clear mandate and not be expected to take on a new responsibility without appropriate adjustments.

The lack of a corporate sponsor for asset management could result in less than an optimum overall corporate strategy with which to support the implementation of a plan. The asset management plan itself cannot be sustained if it is not sufficiently flexible to accommodate new information or needs. It must consider the overall life cycle costs of providing the service and be prepared to make investment decisions accordingly. Alternative investment decisions may result in increased funding requirements.

Finally, there are significant challenges associated with developing a relevant and up-to-date database of infrastructure inventory, and condition and capacity information and analysis.

Asset management provides transparent, rational, and accountable cost-effective management of municipal infrastructure systems. It provides best value for money, saving unnecessary cost. In this capacity, asset management could be viewed as a value management program at strategic and tactical levels (Figure 2–1).

3. Methodology

3.1 Key Principles

Asset management is characterized by:

- a strategic and proactive approach that places a premium on sound data and information, interdepartmental collaboration and an interdisciplinary management approach;
- a comprehensive long-term view of infrastructure performance and cost, and emphasis on sustainability objectives;
- an explicit, visible, and transparent approach that requires effective communication among all its stakeholders; and
- business processes involving investment choices that are policy and performance driven with explicit trade-offs among competing priorities.

3.2 Asset Management Requirements

Asset management is premised on the following component requirements:

- asset value;
- life cycle management;
- sustainability;
- integration of technical and financial plans;
- risk assessment;
- performance measurement; and
- high-level and detailed plans.

3.2.1 Asset Value

It must be recognized that municipal infrastructure assets have monetary value.

3.2.2 Life-Cycle Management

Assets have a limited life expectancy, and their rate of deterioration can be estimated. The life cycle of an asset includes planning, design, construction, operation. Maintenance, rehabilitation, and replacement. Decisions made at any point in the life cycle of an asset could affect the remaining life, and have operational implications and related costs.

3.2.3 Sustainability

Sustainable development has been defined as "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs" (InfraGuide, 2003b). An asset management plan should identify a financial plan to sustain the assets. The financial plan should ensure that resources are available to operate, rehabilitate and, ultimately, replace the assets at the optimum time to achieve the lowest life cycle cost. This requires consistent monitoring of the potential for unintended costs. The plan must also ensure that current users pay a fair share for the service so future users do not have to pay a higher cost for the same level of service.

Sustainable development has been defined as "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs"

(InfraGuide, 2003b)

3.2.4 Integration of Technical and Financial Plans

A municipality should develop an asset management plan that minimizes life cycle costs for infrastructure assets while maintaining an adequate level of service and an acceptable level of risk. An asset management plan should also include a financial plan that identifies the financial investment level required from the public. Ideally, the asset management plan and financial plan should be integrated so the relationship between the level of service and the cost can be quantified. This must all be done in the context of social and environmental impacts.

3.2.5 Risk Assessment

Risk should be managed in any decision-making process. The owner of the assets should analyze and document acceptable risk tolerance. Risk can be quantified by multiplying the probability of failure by the

Asset management plans should be developed for both strategic and operational planning purposes. Strategic planning of policies and programs requires a high-level assessment of the assets, which can be completed using the projected renewal costs and depreciation for a group of assets estimated from replacement costs and life expectancy.

consequences of failure. Traditionally, decision making focused on cost-benefit analyses. Risk management can be used to quantify the cost of risk reduction and the resulting benefits, and can be included as a component in the overall cost-benefit analysis. Risk factors in the analysis include parameters, such as financial, environmental, health, and safety factors. Negative externalities, such as the cost of disruption and delay, and social and environmental degradation also warrant consideration. A good starting point is the best practice on environmental protocols (InfraGuide, 2003c) noted in the references.

3.2.6 Performance Measurement

To optimize an asset management plan, performance of the assets should be monitored regularly and adjustments made at the appropriate stage in an asset life cycle to achieve an acceptable balance between cost, level of service (i.e., performance), and consequential risks.

3.2.7 High-Level and Detailed Plans

Asset management plans should be developed for both strategic and operational planning purposes. Strategic planning of policies and programs requires a high-level assessment of the assets, which can be completed using the projected renewal costs and depreciation for a group of assets estimated from replacement costs and life expectancy. This senior-directed approach is consistent with the accrual accounting method (common in the business world and regulated utilities) in which capital cost expenses include depreciating the value of an asset over its expected service life.

On the other hand, operational planning (e.g., capital planning of projects and maintenance) requires more detailed information on the condition and deterioration rate of the asset. A detailed plan can be completed by using a detailed inventory of the assets including the current condition and deterioration rate. The operational approach lends itself to the cash accounting method, which is predominant in Canadian municipalities. With this method, net capital outlays are expensed on an annual basis. To confirm that the renewal investment is sufficient to sustain the infrastructure systems over the long term, a replicable condition assessment (with a measurement scale) is required on a regular basis.

The magnitude of projected costs to sustain municipal infrastructure over the long term can be quickly determined using the senior-directed approach. On the other hand, it may take several years to develop a comprehensive renewal plan for large municipalities using the operational approach. These two approaches are not conflicting, but complementary to each other. Over time, the results of the operational approach can be used to refine the senior-directed approach.

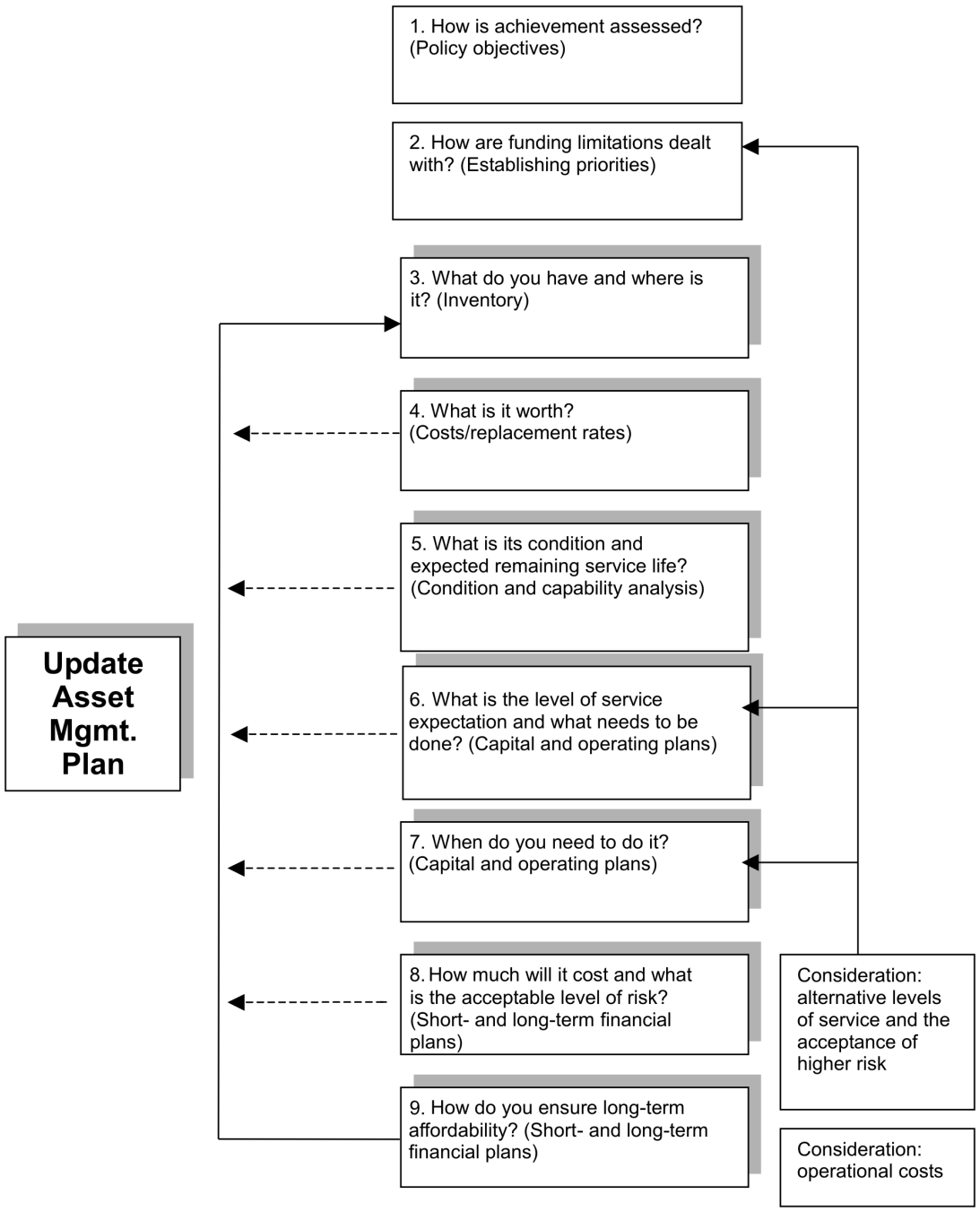
3.3 Essential Elements

The framework for an asset management plan can be described in terms of seven questions.

1. What do you have and where is it? (Inventory)
2. What is it worth? (Costs/replacement rates)
3. What is its condition and expected remaining service life? (Condition and capability analysis)
4. What is the level of service expectation, and what needs to be done? (Capital and operating plans)
5. When do you need to do it? (Capital and operating plans)
6. How much will it cost and what is the acceptable level of risk(s)? (Short- and long-term financial plan)
7. How do you ensure long-term affordability? (Short- and long-term financial plan)

This framework is applicable to both senior-directed and operational approaches. Figure 3–1 illustrates the placement of these questions within an asset management plan. The significance and implications of these questions are explained in the subsequent paragraphs. Finally, the relevance of subordinate or corollary considerations related to alternative levels of service, the acceptance

Figure 3–1: Asset Management Planning Framework



of higher risk and operational costs are also situated within the asset management plan.

3.3.1 How Is Achievement Assessed? (Objectives)

Policy objectives are typically expressed in terms of service levels. Businesses and residents expect certain levels of service from infrastructure providers, and a comprehensive understanding of what is expected aids in effectively planning for infrastructure maintenance, repair, and investment. Corporate or community goals, as reflected in the direction provided by elected officials and municipal administration, generally set the tone for the levels of service the community wants and is willing or able to support financially. These goals should reflect the values of the community.

Figure 3–1:
Asset Management Planning Framework

Policy objectives are typically expressed in terms of service levels. Businesses and residents expect certain levels of service from infrastructure providers, and a comprehensive understanding of what is expected aids in effectively planning for infrastructure maintenance, repair, and investment.

Service levels represent service cost trade-offs, established in a flexible, rational, and transparent manner. As such, they assist and support decision making and investment planning related to the planning, development, operation, maintenance, rehabilitation, and replacement of municipal infrastructure. The obvious benefits in achieving and maintaining levels of service include health and safety, physical/natural development, economic/social development, quality of life/living standards, risk management, and reducing life cycle cost.

Decision makers at the municipal level are constantly engaged in comparing alternative courses of action. The ultimate objective is to sort out the desirable from the undesirable.

3.3.2 How Are Funding Limitations Dealt With? (Priorities)

Declining revenues and a growing demand for maintaining and expanding the quality of municipal infrastructure have placed enormous strain on alternatives. In the context of limited funding, it is crucial that priorities are established both objectively and relative to municipal and corporate policy objectives.

Decision makers at the municipal level are constantly engaged in comparing alternative courses of action. The ultimate objective is to sort out the desirable from the undesirable. Models are often put in place to assure that the decision-making process is rational and objective; one way is through the use of an asset management plan, which allows alternatives to be assessed objectively in correlation to strategic policy objectives.

3.3.3 What Do you Have and Where Is It? (Inventory)

The senior-directed approach requires an estimate of the quantity of the asset group (e.g., total length of water main). If the quantity is not readily available, it may be estimated by pro-rating quantities for other municipalities based on population.

For the operational approach, a detailed inventory is required for each component, encompassing such characteristics as pipe length, diameter, material, and year of installation. *Best Practices for Utility-Based Data* (InfraGuide, 2003d) as a guide for iidentifying, storing, and managing sewer and water system data. This best practice can be adapted for roads and other utilities.

The level of detail in either approach will depend on the availability and requirement of data.

3.3.4 What Is It Worth? (Costs/Replacement Rates)

Several techniques have been used to establish the value of municipal infrastructure assets, including original book value, appreciated book value, and replacement value.

For renewal planning, replacement cost is generally the preferred method for quantifying the value of an asset. For the senior-directed approach, an average unit replacement cost can be used for a group of assets. A more detailed cost estimate is usually warranted when using the operational approach. For example, unit costs can be estimated for each pipe size when estimating the value of water distribution and wastewater collection systems.

3.3.5 What Is Its Condition and Expected Remaining Service Life? (Condition and Capability Analysis)

For the senior-directed approach, the average age of the asset group can be used as an indicator of its condition. Examples of asset condition assessments include system-wide investigations while others target condition assessment of high-risk system components.

For the operational approach, data should be compiled on the condition and performance of each component. A replicable condition assessment protocol, such as determination models, should be adopted (with a measurement scale) to provide a consistent basis for monitoring the condition of each component. The value of an asset can be used to determine an appropriate level of effort for its condition assessment (i.e., inspect the expensive assets as they are more expensive to replace).

3.3.6 What Is the Level of Service Expectation and What Needs To Be Done? (Capital and Operating Plans)

Typically, there are several alternatives for renewal of municipal road, sewer, and water systems. Each alternative could produce a different service life and a different capital cost. The life cycle costs (including current renewal cost, future maintenance and operating costs, and future renewal costs) as well as social costs for each alternative should be estimated to identify the preferred alternative. The renewal plans for all these systems should be integrated to minimize overall costs and disruption.

3.3.7 When Do You Need To Do It? (Capital and Operating Plans)

For the senior-directed approach, the remaining service life of an asset group can be estimated by subtracting the average age of the asset group from the typical service life estimates for that asset group.

For the operational approach, the remaining service life of a component can be estimated based on its age, current condition, and modelled deterioration rate. The deterioration rate of any asset can be estimated by comparing the current condition and that from previous inspections with the age and condition of a selection of similar assets. It is also possible to consider potential economic growth and the related increase in the tax base, as well as integrated "corridor rehabilitation." In this case, a multi-attribute decision-support system can be used.

3.3.8 How Much Will It Cost and What Is the Acceptable Level of Risk? (Short-and Long-Term Financial Plans)

Based on the renewal priorities and asset valuation determined in the previous steps, it is possible to project the costs for infrastructure renewal. As noted previously, the senior-directed approach should be used for strategic planning whereas the operational approach should be used for operational planning. The renewal costs from both the operational approach and the senior-directed approach should be compared to ensure the short- and long-term plans are consistent.

3.3.9 How Do You Ensure Long-Term Affordability? (Short- and Long-Term Financial Plans)

It is important to develop a financial plan that demonstrates how revenues will cover the projected costs for infrastructure management, including renewal. Municipal council should endorse the financial plan so a direct linkage can be made between renewal costs and the level of service.

It is important to project renewal costs over at least one life cycle for each component so a financial plan can be developed that anticipates any projected increases in cost. The overall plan should encompass one life cycle of the longest-lived component of the system.

Two examples in the best practice, *Developing a Water Distribution System Renewal Plan* (InfraGuide, 2004), illustrate the application of the senior-directed and operational approaches to renewal planning for water distribution systems. These approaches can beadapted to project the renewal costs for municipal road and sewer systems.

3.4 Data Collection

Effective asset management begins with reliable, useful, and consistent data.

The asset management plan should address data needs and data quality as well as data integration, accessibility, and maintenance.

InfraGuide has published *Best Practices for Utility-Based Data* (InfraGuide, 2003d) that presents a foundation and guide for identifying, storing, and managing sewer and water system data. It can be adapted for roads and other utilities and recommends the use of a documented data model/structure, data collection standards, standard data units, and standard location referencing. It also makes suggestions for collecting, maintaining, properly storing, and effectively managing data.

The deterioration rate of any asset can be estimated by comparing the current condition and that from previous inspections with the age and condition of a selection of similar assets.

All affected departments within a municipality should participate in the preparation of an asset management plan to standardize data collection and promote data sharing. Update the plan periodically to reflect changing needs, new technologies, and new opportunities. In some cases, pilot tests should be initiated to confirm the feasibility and costs of some data collection and management technologies.

All affected departments within a municipality should participate in the preparation of an asset management plan to standardize data collection and promote data sharing.

In light of the significant amount of data required to complete an integrated asset management plan for municipal infrastructure using the operational approach, municipalities should compile the inventories in relational databases. Ideally, the databases should be linked to a geographic information system (GIS) to facilitate spatial analysis and use of the data.

It is highly recommended that municipalities compile an inventory of their current enterprise databases and other data sources (GIS, spreadsheets, word processing files, manual records, etc.) along with a description of the data they contain. Linkages between complementary data should be identified.

The format and content of the databases will vary depending on the size of the municipality, available funding, the severity of the problems or apparent inefficiencies, and the capabilities of municipal staff. In some cases, it may take several years for a municipality to compile a comprehensive inventory of its infrastructure. However, each municipality should adopt an appropriate plan for data collection and management that will eventually allow the municipality to manage its systems proactively in a cost-effective manner. At the outset, the key question is: What information do I need to collect and at what level of detail, to answer specific management questions? Typically, these questions have at their core: How do we identify and prioritize, over the coming years, capital expenditure needs to maintain, repair, and replace the infrastructure asset base, while meeting assigned levels of performance and service? Finally, how data collection will be prioritized must also be answered.

3.4.1 Data Updates

Municipalities should not underestimate the effort required to maintain infrastructure data and keep it up-to-date. Formal quality control processes should be in place to ensure the quality of the data is improved over time. Some municipalities require developers to submit infrastructure data in an approved format for new subdivisions.

4. Implementation

4.1 Implementation Needs

"Asset management is a comprehensive business strategy employing people, information, and technology to effectively and efficiently allocate available funds amongst valid and competing asset needs" (TAC, 1999).

4.1.1 People

As always, people are the most valuable resource for any endeavour. A successful implementation of asset management will require commitment from all levels within the municipality. A "champion" should be appointed to lead the asset management team and report to senior management at the municipality.

The asset management team, reporting to the champion, should include representatives from the various departments within the municipality (e.g., planning, design and construction, operations and maintenance, customer service, finance, information technology). In some cases, representatives from external agencies (e.g., utility companies), elected officials, and the public should also be included. This participation may take the form of asset management teams or, alternatively, public advisory and/or utility advisory committees. External advisors may be enlisted to assist with the development and implementation of the asset management plan.

In some municipalities, the implementation of comprehensive asset management may require organizational changes. In these cases, business process redesign and a change management strategy may be required to make the transition as smooth as possible.

4.1.2 Information

Effective information management is critical to the success of asset management. The ability to provide feedback throughout the life cycle of an asset is essential to manage it effectively. Feedback will, over time, allow the municipality to optimize the management of its assets in terms of life cycle costs, level of service, and risk. Ideally, information should be shared among the various departments within a municipality.

4.1.3 Information Technology

Information technology (IT) continues to evolve rapidly. It is now possible to gather, store, analyze, retrieve, and communicate enormous quantities of data. Ideally, information technology should integrate the following systems within a municipality:

- maintenance management system;
- customer information system;
- purchasing;
- finance and human resources;
- mapping and asset inventory management systems;
- capital asset plans;
- operations, such as water meter reading, supervisory control and data acquisition (SCADA), and laboratory information management systems (LIMS); and
- other applications (e.g., hydraulic models, traffic models).

Since the development of a detailed asset management plan requires extensive data, with condition rating systems and deterioration models as well as decision-support systems, numerous software tools have been developed. Some well-developed pavement management systems provide most of the functionality required by an asset management system for roads. However, maintenance management systems for water and wastewater systems typically focus on the maintenance of these systems and do not adequately address their renewal requirements and financial plan.

As always, people are the most valuable resource for any endeavour. A successful implementation of asset management will require commitment from all levels within the municipality.

Municipalities should also recognize that they do not have to compile a detailed inventory of their entire infrastructure before they can start applying asset management.

4.1.4 Implementation of Computerized Asset Management Systems

Several references describe the process for implementing a computerized asset management system (e.g., NZ National Asset Management Steering Group, 2000; TransEducation Program, 2000). One reference (Lemer, 2002) lists the names of several companies that have developed commercially available software for infrastructure asset management. However, this reference states: "None of the packages available in early 2002 provide a comprehensive solution for infrastructure asset management." It is important to realize that software is only a tool, and the data are more valuable than the software.

4.1.5 Business Plan

A business plan should be developed for implementing asset management. It should clearly outline the expected costs and benefits of the implementation. Senior management at the municipality should endorse the business plan.

4.1.6 Implementation Plan

An implementation plan should identify the short- and long-term objectives of the asset management plan, a work plan, roles and responsibilities, schedule and budget for various milestones, as well as deliverables. The implementation plan should be updated periodically to reflect current information and priorities.

To facilitate buy-in from stakeholders, the implementation plan should address a few problems that can be easily resolved (i.e., "quick wins"). Municipalities should also recognize that they do not have to compile a detailed inventory of their entire infrastructure before they can start applying asset management. With proper planning, municipalities can compile an inventory and conduct a condition assessment of their systems over a period of years.

While several references describe the process for implementing asset management systems, the *Transportation Asset Management Guide* (NCHRP, 2002) includes a self-assessment exercise to characterize a municipality's current asset management practices and identify specific opportunities for improvement.

4.1.7 Challenges

Municipalities must overcome institutional, technical, and funding challenges before they can successfully implement asset management.

Institutional challenges:

- need for leadership and consistent advocacy (senior level commitment); and
- organizational issues (conflicting priorities, lack of resources, poor communication between departments, silos of knowledge and responsibilities, lack of training, reliance on other agencies).

Technical challenges:

- limitations of asset management systems;
- no data standards, performance measures, and maintenance standards;
- lack of automated and cost-effective non-invasive and non-destructive inspection and condition assessment tools;
- no domain-specific decision-support systems to assist in establishing the priorities among competing renewal projects; and
- the lack of life cycle performance information and of information to quantify social and environmental costs.

Funding challenges:

- inadequate funding; and
- the lack of ongoing funding support.

Several measures can be used to address these challenges: improving communication, education, training, and advance planning. Appendix A describes the implementation of asset management systems in several Canadian municipalities.

4.2 Emerging Trends

Numerous studies and initiatives intended to improve our understanding and appreciation of municipal infrastructure illustrate emerging trends in asset management. Among these are:

- municipal infrastructure investment planning;
- the National Round Table on the Environment and the Economy;
- the Technology Road Map;
- increased awareness of the importance of benchmarking;
- the development of technology tools;
- recent changes to government regulations;
- increased use of public-private partnerships; and
- the implementation of continuous improvement plans.

4.2.1 Municipal Infrastructure Investment Planning

The Institute for Research in Construction (IRC) is conducting a three-year project to evaluate and develop prototype support tools and techniques to help asset managers with municipal infrastructure investment planning (MIIP). The National Research Council, Department of National Defence and several municipalities fund the MIIP project. Additional information is available from <www.irc.nrc-cnrc.gc.ca/uir/miip/>.

4.2.2 National Round Table on the Environment and the Economy

The National Round Table on the Environment and the Economy (NRTEE) acts as a catalyst in identifying, explaining, and promoting, in all sectors of Canadian society and in all regions of Canada, principles and practices of sustainable development. Specifically, NRTEE explores issues that have both environmental and economic implications, and attempts to identify actions that will balance economic prosperity with environmental preservation. The management of municipal infrastructure assets clearly falls within this mandate. This is illustrated by reference to the Round Table's "Environmental Quality in Canadian Cities: The Federal Role" in which life-cycle costing analyses of proposed infrastructure projects and alternatives are encouraged.

4.2.3 Technology Road Map

Four national organizations (Canadian Society for Civil Engineering, Canadian Council of Professional Engineers, Canadian Public Works Association, and the National Research Council) have published the Technology Road Map (TRM) for Canada's civil infrastructure systems over the next decade. (A copy of the TRM can be downloaded from <www.cscs.ca>.) The TRM represents a national consensus on the current state of civil infrastructure systems (CIS), a vision for the industry and a strategy for meeting the long-term needs of Canada's CIS through technology innovation.

The Technology Road Map (TRM) represents a national consensus on the current state of civil infrastructure systems (CIS), a vision for the industry and a strategy for meeting the long-term needs of Canada's CIS through technology innovation.

4.2.4 Benchmarking

Benchmarking is defined as "a systematic process of searching for best practices, innovative ideas, and highly effective operating procedures that lead to superior performance—and then adapting those practices, ideas, and procedures to improve the performance of one's own organization" (AWWA, 1996).

There are two types of benchmarking (AwwaRF, 1996).

Metric benchmarking is the quantitative measurement of performance in terms of inputs, outputs, outcomes and the relationships between them.

Process benchmarking is the mapping of one's own process and subsequent comparison of your process with those of other companies with exemplary performance in a similar process.

Opportunities for private companies to participate in the delivery, ownership, operation, and financing of municipal infrastructure are expected to increase over time.

Several metric benchmarking studies have recently been completed (or are being conducted) in Canada to compare the performance of municipalities in terms of various technical and financial indicators. These include:

- the Ontario Municipal Chief Administrative Officers Benchmarking Initiative (OMBI) <www.caobenchmarking.ca>;
- the Ontario Municipal Performance Measurement Program (MPMP) <www.nationmun.ca/MPMP2001.htm>; and
- the Canadian National Water and Wastewater Benchmarking Partnership.

Caution must be used when using metric benchmarking since performance measures do not necessarily account for the unique circumstances within each municipality (e.g., demographics, climate). Furthermore, financial performance measures do not provide a true indication of the efficiency of a municipality. Nevertheless, an analysis of trends in performance indicators over several years will allow a municipality to determine whether its performance is improving.

4.2.5 Technology Tools

Rapid advances continue in the development of technology tools, such as asset management software, GIS, data collection tools (e.g., GPS), inspection and operation technologies, and rehabilitation technologies. Some municipalities have also started using the Internet for customer service, information sharing, event management, and e-commerce.

4.2.6 Regulations

In 2002, the Ontario government passed Bill 175 *(The Sustainable Water and Sewage System Act)*. This Act makes it mandatory for Ontario municipalities to assess and report on the full costs of providing water and sewage services, and then to prepare and implement a plan for recovering those costs. Similar legislation may be enacted in other parts of Canada over time.

4.2.7 Public-Private Partnerships

Opportunities for private companies to participate in the delivery, ownership, operation, and financing of municipal infrastructure are expected to increase over time. Comprehensive asset management will improve the opportunities for competitive service delivery through an improved ability to articulate needs and evaluate alternative project delivery methods. Finally, the use of asset management planning may improve the selection method used to enter into public-private partnerships.

4.2.8 Continuous Improvement

Some municipalities have implemented continuous improvement programs through AWWA's QualServe program, ISO 9000, and ISO 14000; others have developed an environmental management system. A new ISO standard (ISO/TC 224) is being developed to address service activities related to drinking water and sewerage.

4.3 Application In Small or Remote Municipalities

Asset management is applicable to all municipalities regardless of size and location. Municipalities should develop an implementation plan that maximizes the use of their existing data and tools. The plan must be tailored for each municipality to account for its size, organizational structure, available data and tools, condition of its systems, funding, and targeted levels of service. The implementation plan should strive for continuous improvement.

Strategic planning can be carried out with the senior-directed approach using an electronic spreadsheet to quantify the value of the infrastructure and the long-term investment needed to sustain it.

Operational planning requires municipalities to compile an inventory of their municipal infrastructure. As a minimum, scaled maps should be prepared for the sewer and water

networks to indicate the pipe size, material, and year of installation. A similar map should be prepared to indicate the width of roads, road standard (e.g., rural, urban), and surface treatment. Identification numbers assigned to each component in a system allow all condition and performance data to be referenced to a component.

4.3.1 Small Municipalities

For small municipalities, the next step in the implementation of asset management should include the implementation of a maintenance management system and the preparation of a renewal plan. Small municipalities will not likely have all the in-house expertise required to implement asset management. Furthermore, it may not be cost effective for small municipalities to use some asset management technologies.

The Province of Alberta and several municipal associations have sponsored an initiative called the Alberta Municipal Infrastructure Management System (MIMS). MIMS is an affordable, easy to use set of tools to assist municipalities in managing and sustaining their infrastructure through solid decision making. It allows users to track municipal infrastructure assets for roads, water, storm, and sanitary sewer networks. Users know what they own and its current state. The information can be used for capital planning tasks, such as forecasting, budgeting, and funding allocations.

MIMS includes a data registry as well as GIS capabilities. It also has a self-assessment tool to assist municipalities in identifying the gap between current infrastructure data and the appropriate data that should be collected. Additional information on MIMS can be obtained from <www.albertamims.org>.

4.3.2 Remote Municipalities

Remote municipalities may not have access to some technologies for data collection, inspection, and renewal of municipal infrastructure. Even though municipal staff generally have local knowledge and expertise in managing municipal infrastructure, this knowledge can be lost with the person (corporate memory loss); therefore, asset management should still be implemented to ensure continuity of knowledge.

For small municipalities, the next step in the implementation of asset management should include the implementation of a maintenance management system and the preparation of a renewal plan.

5. Evaluation

The following points describe several measures that can be used to evaluate the effectiveness of asset management.

- Monitor the condition of the infrastructure to ensure an adequate level of service is maintained over the long term. A replicable condition rating system (with a measurement scale) should be used. For example, many Canadian municipalities have adopted the sewer rating system developed by the Water Research Centre in the United Kingdom (WRc, 1986). Similarly, many Canadian municipalities use the Pavement Quality Index (TAC, 1997) to quantify the condition of roads.
- Monitor the performance of the infrastructure to ensure an adequate level of service is maintained over the long term and to assess the efficiency and effectiveness of the municipality. Technical performance measures (e.g., number of water main breaks, number of complaints, number of sewer blockages) can be used to track the performance of the infrastructure. Financial performance measures (e.g., cost to treat 1 cubic metre of water, total operating cost per km of sewer) can be used to assess the efficiency of the service.
- Track unplanned spending on an annual basis to confirm that the asset management plan is effective. Implementation of an asset management plan should reduce the unplanned spending over several years.
- Track total spending, on an annual basis, for each program as well as condition and performance data to optimize spending. Activity-based costing (ABC) and activity-based management (ABM) will assist in optimizing funding and budgets.
- Conduct a value engineering review of the asset management plan.
- Conduct a risk assessment study to confirm that risks are effectively quantified and mitigated.
- Monitor program delivery measures to confirm that the asset management plan is on schedule and budget.
- Conduct benchmarking to compare the performance of the municipality with others. This may identify areas for improvement.

Appendix A:
Successful Implementations

There are many examples of successful asset management implementations in Canada. Five are summarized here.

City of Surrey, British Columbia

A city-wide asset management program for the City of Surrey has been underway since 1996. Up until 1996, each department operated autonomously, with separate asset management systems and approaches. The City saw the potential to eliminate systems and process redundancy, to combine and leverage staff and inventory, and to achieve greater efficiency by capitalizing on possible synergies.

Objectives

The objective of the city-wide asset management program was to:

- find a common communication platform;
- plan and measure those processes and programs which would lead to lower cost of ownership and better performance;
- introduce measurement control points and collection of performance measurement metrics;
- increase the use of preventive maintenance, condition monitoring, failure code analysis, and reports;
- support business process (re)engineering for increased workflow efficiency and effectiveness;
- encourage continuous improvement of total costs, performance, and user satisfaction;
- infuse the use of best practices into the process; and
- measure actual results to verify improvement plans.

Approach

Surrey began its asset management program by first defining its goals "to improve customer service by ensuring all City assets are properly maintained through cost effective and process efficient means." The City's asset base is very diverse, with pumps and controls, water, sewer, roads, drainage, traffic, park and trees, and corporate facilities. Assets can range from brand new to almost 100 years old, and are in various life cycle stages and conditions.

Implementation began with a team approach by representatives from each department including Engineering, Corporate Facilities, Parks, Finance and Information Technology. Ongoing implementation and maintenance of the system was transferred after Phase I of the project to the individual departments.

Asset management requires a strong and stable technological base, with the flexibility to be used by each department with its unique business requirements, and is a strategic lever for an asset management program. Like other organizations in an asset-intensive industry, the design group faced some basic philosophical issues. Should they go with a production-centric or a financial-centric approach to technology? The result: a production-centric philosophy and a customizable, best-of-breed solution to assist in the overall asset management solution, to help track the total cost of ownership (TCO) of assets, and to ensure the City's stewardship role was addressed. Asset information, which had been captured in legacy systems, was transferred into the new system, and previously unrecorded asset data were manually entered into the system. Immediate cost savings resulted through the reduction in

The asset management program has been the catalyst for significant changes in business processes along with a raised awareness of regulatory requirements, budgeting limitations, and the need for long-term planning.

the number of legacy systems and in the duplication of data entry.

Through the city-wide approach, which was undertaken by a steering committee, a design team and focus groups, the City looked at the costs of *not* providing asset management, assessed the business requirements, and associated gaps, provided cost-benefit analysis, and defined the project implementation and ongoing management.

Strategies applied in the City of Surrey were revised a number of times as the asset management team acquired more knowledge and expertise with asset management. Business processes are constantly refined to obtain efficiencies, or to attain goals set through performance metric evaluations. Capital budgeting is beginning to be driven by asset failures predicted through the asset management program, instead of emergency and short-term plans.

Benefits

The asset management program has been the catalyst for significant changes in business processes along with a raised awareness of regulatory requirements, budgeting limitations, and the need for long-term planning.

Other non-quantifiable gains made through the process have been the establishment of defined and documented business processes for many functions throughout the departments. This has included improved reporting capabilities; improved process efficiencies in purchasing, contracts, invoicing and cataloguing; full integration with the City's financial system; the ability to retrieve the history of materials and purchasing transactions; improved business processes and work flow in many functional areas; clearer delineation of individual responsibilities within the processes and functional areas; and improved computer literacy of staff.

These are fundamental building blocks in establishing an asset management program.

From these processes, and through the capture of asset data, key performance indicators are being established and monitored, which will provide unique insight into how the City should structure its continued improvement initiative.

Further benefits to a fully implemented asset management program have included enhanced risk management, establishment of performance metrics, efficiency gains, a reduction in corporate memory loss, and a central repository for asset and costing data.

Payback Period

The payback period for the investment was identified as seven years after full implementation. Full implementation included completion of detailed asset information and associated preventive maintenance and job plans as well as integration to other operational systems. The City considers itself to be two years away from city-wide full implementation, but the benefits already gained are considerable. What is exciting are the significant opportunities to realize future efficiencies in labour productivity and increased reliability of the assets in use.

Future Projects

Future projects include integration with GIS, a pavement management system, customization of a processing and tracking system (AMANDA), a parks irrigation system and a process control system (SCADA). A Web-based platform is being evaluated for the next upgrade. Hand-held technology has been implemented in a pilot program. Based on the success of the project, the integration possibilities will be extended for use by the project team as a whole.

Asset management is accomplished through the concerted efforts of technicians, clerical, trades, and management staff, and through a supportive business culture for asset management.

City of Hamilton, Ontario

The Asset Management Section at the City of Hamilton was formed in 2001 during restructuring initiatives related to the amalgamation of the Region of Hamilton-Wentworth and six former area municipalities. The Asset Management Section is organizationally structured within the Public Works Department.

The strategies applied in the City of Hamilton include:

- adoption of an organizational structure that reflects the various infrastructure systems being managed;
- full integration of all individual asset information data sets and programming initiatives; and
- development of capital works programs that address all the needs of a given section of municipal right-of-way.

Asset management continually reviews, develops, and implements trenchless technology for the rehabilitation of the subsurface infrastructure. Existing sewer/water maintenance management systems are being linked through the application of advanced GIS techniques to facilitate a completely integrated asset management approach.

Strategies are being implemented in conjunction with the development and implementation of bridge and pavement management systems. These systems have the technical capability to move the statistical analysis into the GIS format required for trend analysis. This work includes the development of land use data applications to address the socio-economic factors related to infrastructure programming initiatives.

Asset management is responsible for all capital budgeting related to the City of Hamilton. This team compiles all required capital project and account data into a budget for presentation to City Council. The approved budget is monitored and regular budget variance reports are generated for senior management teams.

The Asset Management Section is actively pursuing other initiatives, such as project management of a data collection and asset creation exercise for right-of-way infrastructure assets: sidewalks, catch basins, signs, and trees.

City of Québec, Quebec

The Development and Planning Section at the City of Québec was formed in 2001 during restructuring initiatives related to the amalgamation of the City of Québec and 12 former area municipalities. The Development and Planning Section is organizationally structured into the Engineering Service. The infrastructure assessment/project co-ordination role is accomplished by technical specialists working in the individual infrastructure asset areas. The specific areas include surface infrastructure, subsurface infrastructure, and infrastructure management systems.

The strategies applied in the City of Québec include:

- adoption of an organizational structure that reflects the various infrastructure systems being managed;
- full integration of all individual asset information data sets and programming initiatives; and
- development of capital works programs that address all the needs of a given section of municipal right-of-way.

The subsurface infrastructure team has developed and implemented an integrated asset management approach. Enhanced capability is being developed within the existing sewer and water maintenance management system to enable condition analysis of the sewer system from the network level. This team is responsible for the administration of the City's CCTV, zoom camera, and remote field eddy current contracts.

These strategies are being implemented in conjunction with the development and implementation of pavement management

systems. The Surface Infrastructure Team is also working on refinements to the decision model within that system. The entire pavement will be inspected and the data implemented into a road management system, capable of life cycle analysis and budget forecasting.

The infrastructure management systems team has been instrumental in the development of the integrated data sets and the automation of the various data set implementation exercises. This team provides the technical capability to move the statistical analysis into the GIS format required for trend analysis at the system level. Work has included the development of land use data applications to address the socio-economic factors related to infrastructure programming initiatives.

City of Edmonton, Alberta

To ensure that the City would be in satisfactory financial condition and could effectively finance services on a continuing basis, Edmonton's civic administration developed the 10-Year Long-Range Financial Plan in the mid-1990s. Results from preliminary research undertaken in 1998 confirmed a sizeable and growing discrepancy between infrastructure requirements and the funds available to finance those requirements, otherwise known as the infrastructure gap. It was clear that a comprehensive strategy was required, as the City could not afford to invest and re-invest in the rehabilitation and development of its physical assets. A direct reaction to those research findings was the development of the 1998 Infrastructure Strategy.

The Infrastructure Strategy addresses the funding challenges associated with ageing infrastructure and a booming economy. The overall goal is to ensure the City's infrastructure is in a good state of repair, that expansion and restoration programs are sufficiently funded, and that these programs are as efficient and effective as possible. The Office of Infrastructure was created in 2000 to develop and implement strategies, tools, and processes that support the City's plans and priorities for the sustainable renewal, upgrading, and expansion of infrastructure. Another essential component for the successful implementation of the strategy is a communications plan to raise awareness of infrastructure issues and solicit support from key stakeholders and citizens at large.

Senior management supports the Infrastructure Strategy initiative and provides the basis for co-ordination and co-operation between internal departments. To fulfil the need for input by external stakeholders, the Infrastructure Technical Advisory Committee (ITAC) was also established. It consists of technical stakeholders with expertise in design, development, and management, and provides an external perspective and guidance to the City. Representing a broad cross-section of professional organizations, business associations, community groups, academia, and provincial departments, ITAC's input assists the City as it continues to refine and validate strategies, processes, and planning tools.

The physical assets, developed and used by the City of Edmonton to support the community's social and economic activities, are organized into 12 key infrastructure areas and include such diverse assets as drainage and sewers, roads, parks, buildings, recreation facilities, fleet vehicles, transit, traffic control, waste management, computer networks, affordable housing, and library resources. Since 2000, the City has collected data on infrastructure inventory, replacement value, average age, and expected asset life, as well as financial investment needs and funding information for these assets. This, in addition to a standardized rating system developed in 2001, provides the foundation for effective asset management and decision making.

A five-point standardized rating system was developed to evaluate the state and condition of the City's infrastructure assets. Three key criteria—physical condition, demand/capacity, and functionality—are used to apply a consistent method of comparison between dissimilar infrastructure elements. By identifying which assets are most in need of

repair, the rating system provides a high-level corporate perspective, which contributes to improved decision making in the capital priorities planning process. The rating system validates investment requirements by capturing the City's infrastructure asset inventory and highlighting infrastructure elements with the greatest need for funding. Additional innovative tools, such as a risk assessment methodology, in combination with confirmed asset management techniques, such as life cycle costing, are being developed and evaluated.

The risk assessment methodology will apply deterioration functions to quantify the probability and impact of infrastructure failure in relation to funding deficiencies. This will enable the prediction of the future state and condition of infrastructure assets in relation to current investment scenarios. By determining the severity of the risks associated with current infrastructure investment, the civic administration will be able to compare disparate infrastructure elements on a corporate level and determine which critical areas require the most urgent action.

Life cycle costing, on the other hand, enables the assessment of future investment requirements by considering the total cost of an asset over its life expectancy rather than limiting decisions to initial construction costs. The Mobile Equipment Services Branch, having successfully implemented life cycle costing management, reports that the practice has proven to be cost effective. The use of life cycle costing is being promoted on a corporate-wide basis.

Successful implementation of the Infrastructure Strategy also requires the integration of the strategy with the City's major corporate initiatives. It is essential that the asset inventory, state and condition asset ratings, and critical need areas all be taken into consideration as Edmonton develops its annual Corporate Business Plan, Capital Priorities Plan and 10-Year Long-Range Financial Plan. Internally, the City has initiated preliminary talks in an effort to better standardize, simplify, and integrate IT systems, which will enhance asset management practices. It is expected that, according to the Enterprise Resource Planning initiative, the City's Spatial Land Inventory Management database, Computerized Maintenance Management system, Planning One Stop Service (POSSE) and Systems, Applications and Products (SAP) in Data Processing will be integrated to facilitate ease of use and information sharing.

Despite the development and use of those tools and processes, adequate financial resources are still needed. The City of Edmonton is exploring alternative funding strategies to help reduce the growing infrastructure gap. In 2003, City Council approved land drainage as a utility, resulting in self-sustained fee-for-service delivery and the consequent removal of drainage services from the City's tax-supported capital budget projections. The Sanitary Servicing Strategy Fund is a partnership between the City and developers and builders to finance jointly the construction of major sanitary sewers to support development. This initiative has reduced the civic fiscal burden and enabled development to proceed that might otherwise have been delayed. The City has also introduced another cost-sharing partnership to ensure that developers pay their share of new infrastructure; the Arterial Roadway Assessment partners with developers in the construction of arterial roadways to service newly developed areas. For the first time since 1983, the City of Edmonton revised its debt management fiscal policy to allow the municipality the option of assuming tax-supported debt to pay for critical infrastructure projects that would otherwise be unfunded. City Council has given approval to borrowing $50 million in 2003 and will consider borrowing the same amount for another four years to support capital infrastructure projects.

Edmonton will continue to implement the Infrastructure Strategy as it develops corporate and departmental business plans and other key initiatives. This includes the

development and deployment of effective and efficient infrastructure management tools, processes, and strategies to assign priorities for the sustainable renewal, upgrading, and expansion of infrastructure. The City will also continue to explore new funding approaches and management strategies to address the infrastructure gap.

City of Kitchener, Ontario

The City of Kitchener is designated as a lower tier municipality within the province of Ontario with a population of approximately 197,000. Although within a regional municipality, the City is responsible for the delivery and maintenance of a significant portion of "hard" municipal services and associated infrastructure. This includes full responsibility for all sidewalks, sanitary sewers, natural gas lines, and most roads, storm sewers, and water mains.

The goal of the City's Integrated Asset Management System is to gather, inventory, store, and analyze all available data regarding the state of municipal infrastructure. From this, City staff are developing a complete understanding of the extent, condition, and operating performance of the networks. This will lead to better understanding and development of efficient proactive strategies concerning maintenance, rehabilitation, and reconstruction of the City's infrastructure and improved cost effectiveness of the divisional work processes.

In 1995, the City of Kitchener's Engineering Division embarked on the development and implementation of a GIS-based integrated infrastructure management system (IIMS). Since then, considerable effort has been expended in the systematic collection of data and the development of analysis tools and criteria. Through systematic collection of sanitary sewer data, water main data and road inventories, the City has developed a prioritized plan for upgrades to infrastructure to maintain a sustainable level of funding.

Recent work by the Engineering Division includes the interconnection of work management applications to the infrastructure management tools, and enhancements to the collection and dissemination of data. The City has recently developed a low-cost method of collecting inventory and defect data for sidewalks incorporating GIS technology and is developing a similar process for the collection of road defect inventories.

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